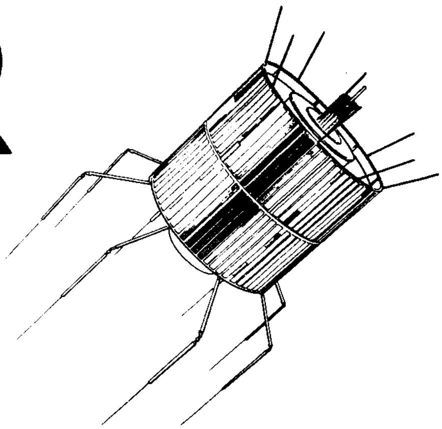
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

TELS. WO 2-4155
WO 3-6925

PRESS KIT

FOR RELEASE: FRIDAY A.M.
December 2, 1966

RELEASE NO: 66-308



PROJECT: ATS-B

(To be launched no earlier than December 6, 1966)

CONTENTS

-End-

11/26/66

NEWS NASA
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546
TELS. WO 2-4155
WO 3-6925

FOR RELEASE: FRIDAY A.M.
December 2, 1966

RELEASE NO: 66-308

FIRST ATS
LAUNCH SET
DECEMBER 6

One of the most versatile spacecraft ever developed, Applications Technology Satellite-B (ATS-B), will be launched by an Atlas-Agena rocket from Cape Kennedy, Fla., no earlier than Dec. 6.

The ATS program consists of a series of five satellites to be launched by the National Aeronautics and Space Administration over the next two and one-half years. They will investigate technology common to a number of spacecraft applications, through flight experiments carried on spin-stabilized and gravity-gradient stabilized spacecraft.

The ATS-B (ATS-I if successfully launched) will be boosted into a synchronous, stationary orbit 22,300 miles over the equator and allowed to drift to an apparently stationary position at 151 degrees west longitude.

It will carry experiments designed to advance the fields of spacecraft communications, meteorology and control technology. At the same time, it will carry a number of scientific experiments to measure the orbital environment of the satellite.

-more-

In addition, radio signals from ATS-B will be used to help determine the ion content of the ionosphere.

The spacecraft will be capable of transmitting wide-band (black-and-white and color TV) and narrow band (voice) communications among stations located in North America, Asia and Australia. It will also be capable of multiple access (a number of ground stations transmitting through the satellite at the same time) communications. The stations are located at Rosman, N.C.; Mojave, Cal.; Kashima, Japan; and Cooby Creek (near Toowoomba), Australia.

NASA has a number of experiments for the first time with the spin stabilized ATS-B. These include:

Two-way VHF voice communications between a ground station and an airplane in flight. Although this is the first voice test, its feasibility was established with one-way teletype signals sent via the Syncom III communications satellite.

Its Spin Scan Cloud Cover (SSCC) camera is expected to return the first high quality cloud cover pictures taken from synchronous orbit. The pictures will show the disk of the Earth with a maximum resolution, depending on spacecraft stability, of two miles and cover up to 54 degrees north and south. It will be able to provide continuous coverage of 39 percent of the Earth during the daytime when so scheduled.

ATS-B will also be used to transmit the first weather data (weather maps and nephanalyses) from the Environmental Science Services Administration (ESSA) facility at Suitland, Md., through ground stations and the satellite to Automatic Picture Transmission (APT) stations in the United States, Japan, and Australia. APT stations are relatively inexpensive units already in operation receiving real time cloud cover pictures of local areas from ESSA and Nimbus satellites. These same units are capable of receiving facsimile data from ATS-B.

An experimental antenna system, Electronically De-spun Antenna, the first of its kind, will be tested with the microwave communications system. It continuously directs a cone-shaped radio beam at the Earth. By rotating the beam in the opposite direction to that of the spacecraft spin, the antenna produces 10 times more power at ground stations on the Earth than would be possible without it.

A low-thrust resistojet will be evaluated for uses such as spin control and orbital maneuvers. It produces a thrust of 450 millionths of a pound -- about equal to the weight of a common house fly. This will be its first flight test.

Another technological experiment is the Nutation Sensor. It is designed to measure the spin axis wobble (nutation) of the spacecraft to within one-thousandth of a degree.

This will be the first attempt to measure nutation with such precision. Nutation must be minimal for a system such as the SSCC camera.

A scientific experiment package, Environmental Measurement Experiment (EME), consists of seven separate experiments to measure the orbital environment of the ATS-B and the effects of the environment on the spacecraft.

The ATS program is directed by NASA's Office of Space Science and Applications. Project management is under the direction of NASA's Goddard Space Flight Center, Greenbelt, Md., with experiments provided by investigators at Government, university and private industry laboratories.

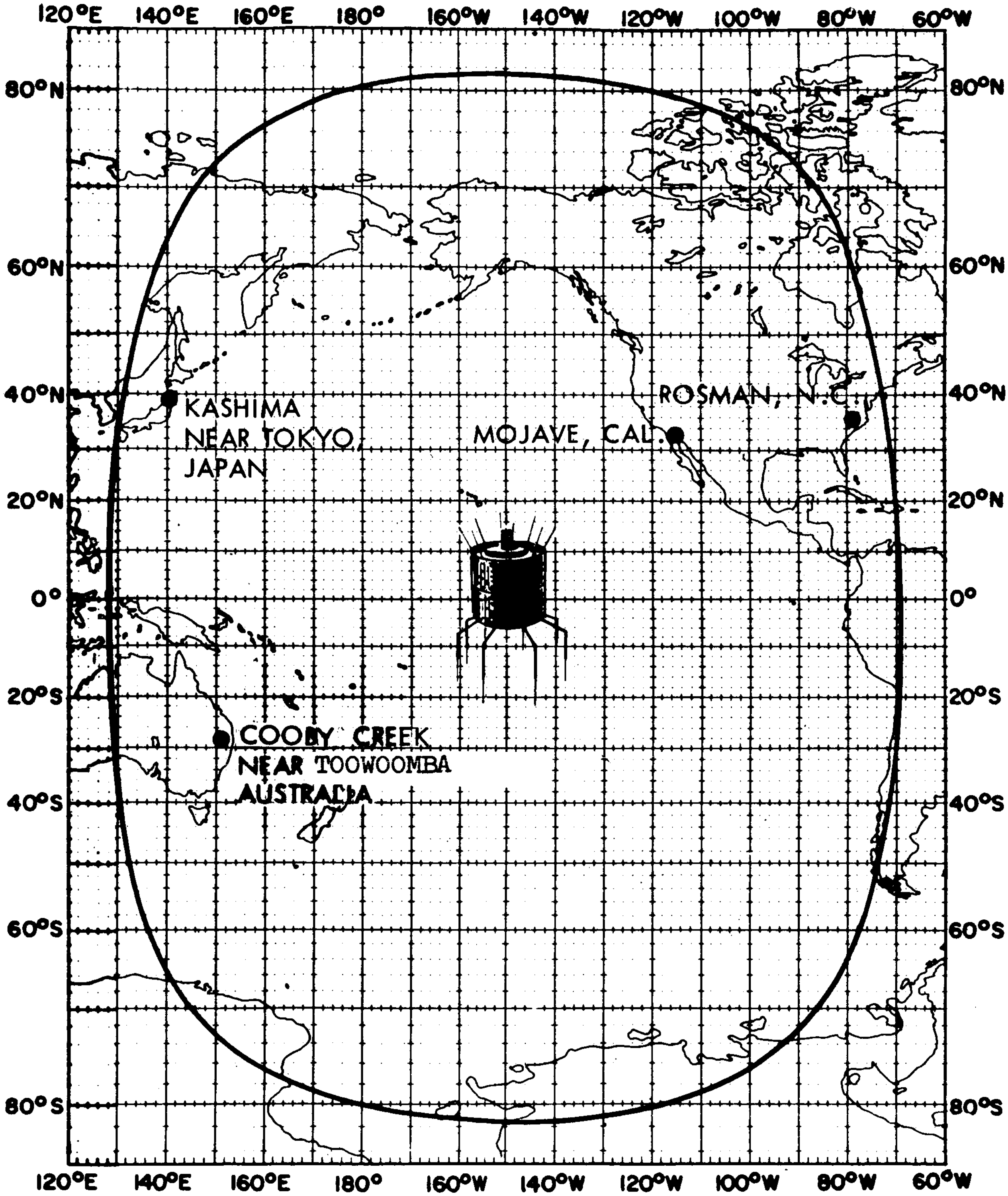
All operations of the ATS-B are coordinated and controlled from the ATS Operations Control Center (ATSOCC) at Goddard. The three ATS ground stations at Rosman, Mojave and Toowoomba are equipped for all of the mission's tests.

Hughes Aircraft Co., Space Systems Division, El Segundo, Cal., is responsible for spacecraft design, development, fabrication and integration of experiments into the spacecraft.

-more-

NASA's Lewis Research Center, Cleveland, is responsible for the Atlas first stage booster and the second stage Agena. General Dynamics/Convair, San Diego, Cal., developed the Atlas and Lockheed Missiles and Space Corp., Sunnyvale, Cal., developed the Agena. Launch operations are directed by Kennedy Space Center, Fla.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)



ATS-B GLOBAL RECEPTION AREA

THE DARK LINE ENCLOSES THE WORLD AREAS FROM WHICH THE ATS-B WILL BE IN VIEW FOR COMMUNICATIONS PURPOSES. THE ATS GROUND STATIONS AND PARTICIPATING STATION ARE INDICATED.

COMMUNICATIONS EXPERIMENTS

Super High Frequency (SHF) Tests - Goddard Space Flight Center

The primary ATS-B communications experiments will be conducted with the two microwave repeaters (receiver/transmitter) which make up the spacecraft's super high frequency (SHF) communications subsystem.

Both repeaters operate in three modes: the first two, (1) multiple-access and (2) frequency translation, are used in the microwave communications tests as described below. The third mode, (3) wideband data, is used for transmitting television pictures from the spacecraft's Spin Scan Cloud Cover (SSCC) camera to the ground. (See section on "meteorological experiments.")

Multiple Access Mode Tests

The basic objective of operating the microwave repeaters in this mode is to evaluate the Single Side Band (SSB) technique for multiple-access communications. This technique is a promising approach to the development of a multiple-access system where two or more ground stations use the spacecraft simultaneously. It holds such promise because it affords a maximum number of voice channels in the minimum bandwidth of the overcroweded radio frequencies.

In the multiple-access mode, the two microwave repeaters serve as telephone relays by permitting the simultaneous two-way interconnection of many ground stations. Use of both repeaters will provide for a total of 1,200 one-way or 600 two-way voice circuits when properly equipped ground stations are used.

During the multiple-station access tests, transmissions from all of the participating ground stations are collected at the spacecraft as a composite SSB signal in the 6,000 megacycle frequency range. This composite signal is converted to a Phase Modulated (PM) signal in the 4,000 MC range by the repeater before retransmission to the receiving ground terminals.

The SSB/PM conversion technique is employed for the multiple-access tests because PM provides a constant power signal which can be amplified in an efficient manner while utilizing a minimum of weight, space and the spacecraft's onboard power. This could not be accomplished if SSB were used for the entire communications loop.

Since SSB signals are particularly sensitive to exact frequencies and power levels, precautions have been taken to insure that these two factors remain as constant as possible.

For example, the ground transmitters use ultra-stable oscillators and automatically compensate for the Doppler effect or apparent frequency shift in signals which results if the spacecraft deviates only slightly from its geo-stationary orbit.

For each degree of inclination that the ATS-B might vary from the equator, the Doppler effect might be as much as 1,200 cycles per second.

Frequency Translation Mode Tests

The two microwave transponders are operated in this mode to evaluate a high quality Frequency Modulation (FM) system for relaying wideband data such as color television, telegraph, digital and facsimile data. The FM system used for these tests is a refinement of the systems used on the Relay, Telstar and Syncom communications satellites.

In the Frequency Translation Mode, FM signals are received from a ground station in the 6,000 MC frequency range and translated to FM signals in the 4,000 MC range before re-transmission to the ground. During the translation, the signals are amplified.

The primary design criteria for the Frequency Modualtion system includes meeting the specifications for color television. Wideband circuitry is utilized throughout the signal chain of the system so that the resulting usable band is 25 MC. This meets all International Radio Consultative Committee (CCIR) recommended television standards when utilized with ground stations appropriately equipped.

Since wide band data transmissions cover a relatively wide range of frequencies, two-way simultaneous transmissions of such data will require the use of both microwave repeaters. In such a case, one ground station will use one complete channel for transmission one way while the cooperating station will monopolize the other microwave channel.

Very High Frequency (VHF) Tests - Goddard Space Flight Center

The ATS-B also carries a special communications repeater (receiver/transmitter) which operates in the Very High Frequency (VHF) range (30 to 300 megacycles). Considered an experiment, this repeater and its antenna system will be evaluated as a relay for two-way voice communications between ground stations and inflight aircraft.

Both the commercial airlines, represented by Aeronautical Radio Inc. (ARINC), and the Federal Aviation Agency (FAA) will schedule flights of their own aircraft for the VHF tests. These airplanes will be custom-equipped with VHF communications equipment for tests.

The VHF repeater is an active frequency translation device which operates like the microwave repeaters when they are used in the frequency translation mode. Frequency Modulated (FM) signals at 149.22 megacycles are received at the spacecraft and translated to FM signals at 135.6 megacycles, amplified and retransmitted. Thus, all communications equipment at the ground stations and aboard the airplanes transmit at the higher frequency and receiver at the lower one. These frequencies were selected to make maximum use of existing VHF equipment.

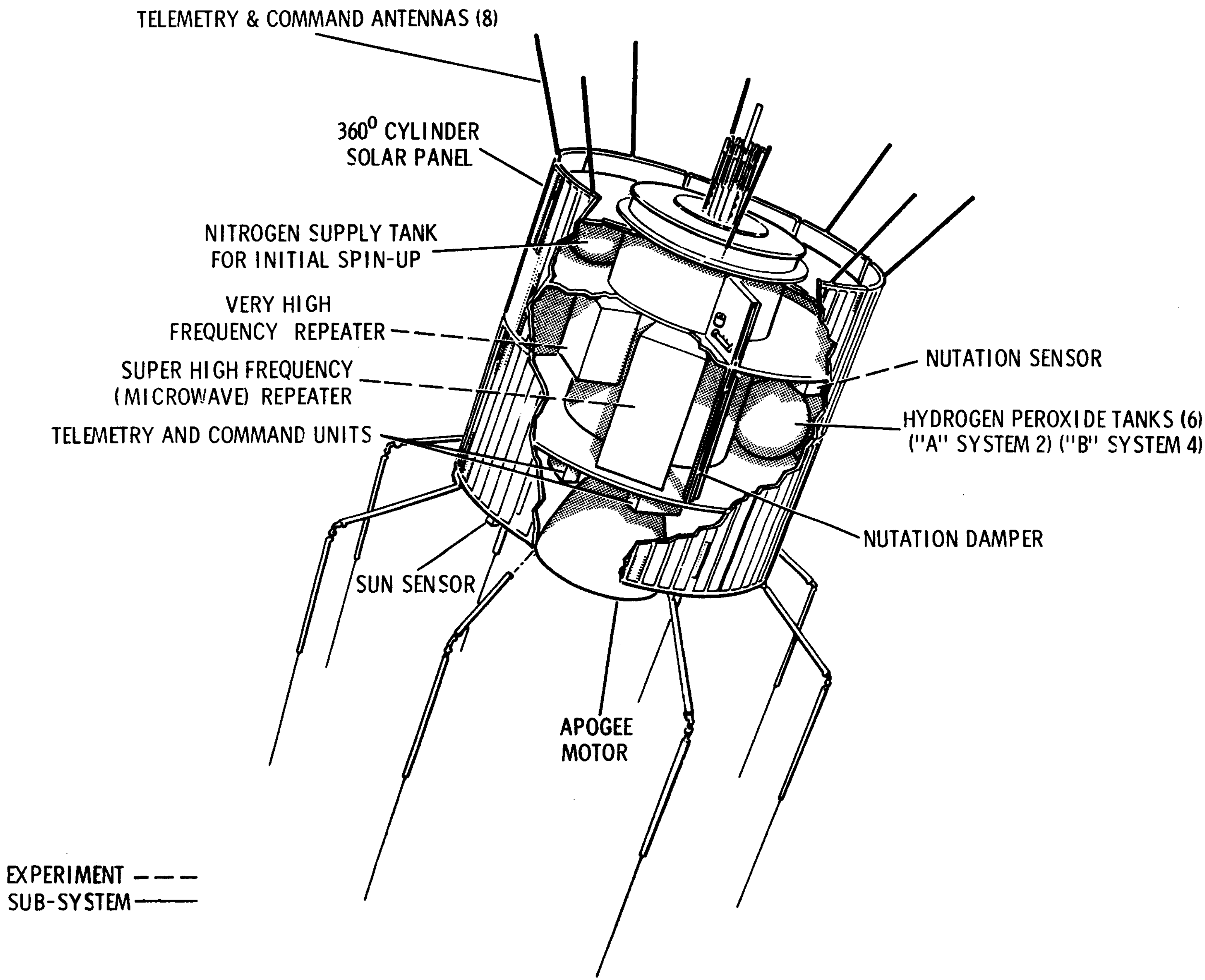
The antenna system for the VHF repeater is a phased-array unit which consists of eight radiating elements located around the base end of the spacecraft. These antennas, which look like spider legs when properly phased, concentrate the energy from the satellite into a beam with a pattern gain of nine decibels.

In addition to tests with participating aircraft, simulated ground-to-aircraft relay tests will be conducted between two ATS ground stations. Aircraft simulation will be possible by degrading the performance of one of the participating stations. This is accomplished by using low power antennas and reducing the radiated power.

During the tests, the airborne and ground terminal performance will be evaluated to help determine how to improve ground station operation and equipment. The more efficient a ground station the less communications equipment is required aboard spacecraft and airplane where space and weight are at a premium.

The FAA plans to use ATS-B for an evaluation of the future use of satellites for relaying very high frequency (VHF) voice communications between air traffic controllers and pilots of airplanes flying over oceanic and sparsely populated land areas.

With presently-used high frequency (HF) communications, aircraft in transoceanic flight are sometimes unable to contact ground stations for periods lasting more than one hour due to static, interference and fading. Satellite relayed VHF should provide the capability for continuous static- and fade-free VHF communications.



ATS - B SYSTEMS AND INTERIOR EXPERIMENTS

To assist in the evaluation of the ATS-B satellite, an FAA C-135 flight check jet will be specially equipped for tests to begin in May, 1967. The plane will be flown to California, then north to Alaska, thence south to a point under the satellite near the equator southeast of the Hawaiian Islands.

Spin Scan Cloud Camera -- University of Wisconsin and Environmental Science Services Administration

A Spin Scan Cloud Camera (SSCC) on the ATS-B satellite will monitor weather developments and motions over a large area of the Earth's surface during selected intervals of time to demonstrate the feasibility and utility of continuous coverage.

Although the TIROS, Nimbus and ESSA satellites provide extremely valuable observations of the Earth's weather, their view of any weather system is fleeting. A synchronous satellite, remaining stationary in relation to the Earth, will permit continuous surveillance of short duration.weather changes over large areas of the globe.

Unlike other spacecraft television camera systems with complex despinning or image motion compensation schemes, the spin scan camera makes use of the spacecraft spin. The west-east or horizontal scan of the camera is generated by the spinning motion of the spacecraft whereas the vertical scan is generated by a mechanical step motor.

The camera employs a reflecting telescope with a five-inch diameter and a folded 10-inch focal length. A defining pinhole aperture is located at the image plane. This combination provides an effective lens aperture number of f/2.

Light from the telescope passes through a filter, which removes some of the blue light scattered by the atmosphere, hence to a photomultiplier tube. Electrons given off by the photomultiplier tube represent about 13 shades of gray. These electrons constitute a current which is amplified and transmitted to the Earth station for reconstruction as a cloud cover photograph.

The picture or frame scan mechanism of the camera scans through an angle of 15 degrees, which corresponds to an Earth coverage from 52.5 degrees north latitude to 52.5 degrees south latitude. Since the complete frame is made up of 2,000 scan lines and the spacecraft is spinning at 100 revolutions per minute, the camera scans 100 horizontal lines each minute. Thus, one picture is produced every 20 minutes. In the normal mode of operation, the telescope is made to retrace to the 52.5 north latitude position at the conclusion of each picture. Retracing takes about two minutes.

Though not designed for astronomical photography, the camera can scan outer space to include the Sun, the Moon and the brighter stars when it is turned away from the Earth. A view of the Moon is useful in providing a means to monitor the camera's sensitivity.

The photographs of the Earth, taken when the ATS-B is on its planned station, will show an area well over a third of a billion square miles. It will extend from the east coast of North America to mid-Australia and from the lower tip of South America to Hudson Bay in Canada.

Weather Facsimile (WEFAX) - NASA - ESSA

Weather data in facsimile format, prepared by ESSA, will be transmitted to the satellite by the ATS Mojave ground station and relayed through the satellite to special ground stations within communications range. In addition, selected spin scan camera pictures will be transmitted via the satellite to the Automatic Picture Transmission (APT) ground readout stations.

The WEFAX experiment is designed to test satellite transmission of facsimile products, and to explore the feasibility of increasing the amount of data available to stations equipped for reception of Automatic Picture Transmission photographs from the ESSA and Nimbus satellites.

The WEFAX experiment will begin after the satellite reaches its planned position above the equator. ESSA's National Meteorological Center and National Environmental Satellite Center, both at Suitland, Md., will prepare data for transmission by ATS-B and send it via landline to the ATS Mojave ground station. The WEFAX field center at Mojave will transmit the data to the spacecraft at the rate of 240 scans per minute. The spacecraft will relay the data via a VHF down-link directly to ground stations equipped to receive and record APT cloud-cover pictures.

APT stations from the east coast of the United States to mid-Australia and Japan will be able to receive the transmissions and they have been invited to participate in the experiment. Participating stations will evaluate the quality of the transmissions, sending samples and comments to Goddard, which will conduct a systems evaluation based on these returns.

Data will be selected for transmission on the basis of value and interest to stations in the Pacific and adjacent areas. A daily alert message giving WEFAX transmission times will be sent on meteorological teletypewriter circuits, and a monthly schedule of transmissions will be mailed to participants.

TECHNOLOGY EXPERIMENTS

Electronically De-spun Antenna System - Goddard Space Flight Center

This experiment will evaluate an antenna system capable of producing a high directional radio beam which can be pointed continuously toward the Earth from a spinning spacecraft in synchronous orbit.

It is dubbed an Electronically De-spun Antenna because it is a phased array system whose directional radio beam is "electronically" de-spun so that it can remain pointed at the Earth. Despinning is necessary because the ATS-B, a spin-stabilized spacecraft turns about 100 revolutions per minute like a gyroscope.

This antenna system, operating at the power levels of the ATS-B, will produce 10 times the effective radiated power that could be achieved without the system. It will be used as the antenna link on the ATS-B during the microwave communications tests. This will be the first use of such an antenna system aboard a spacecraft.

The Electronically De-spun Antenna is designed to produce a radio beam to cover the entire area of the globe in view of the spacecraft. It will be an elliptical beam measuring about 18 degrees north and south and 23 degrees east and west. The net gain or radiated power of this beam will be about 14 decibels.

The basic components of this experiment consist of a circular cluster of 16 radiating elements each measuring eight inches long. A single receiving element, located in the center of the cluster, is 18 inches long. These elements are affixed to the spacecraft and rotate with it.

All of the 16 radiating elements are continuously energized but are phased so that their radiated output tends to reinforce in a given direction. In effect, a main beam of energy is made to radiate in rotation around the spin axis at the same rate as, but in the opposite direction of, the spinning spacecraft. Thus, the rotation of the antenna beam cancels out the spin of the spacecraft to produce a stationary and directional radio beam.

The Electronically De-Spun Antenna is controlled by the Phased Array Control Electronics (PACE) of the spacecraft subsystems. Should this system fail, the antenna would still produce a conventional radiation pattern which would be effective for communications purposes.

Nutation Sensor - Goddard Space Flight Center

This experiment has the primary objective of determing the degree to which a nutation damper will be effective in minimizing the nutation (wobble about the spin-axis) of a spin-stabilized spacecraft. This sensor, capable of measuring nutation angles from five degrees down to a thousandth of a degree, will be controlled by ground command.

No spacecraft has ever been instrumented to measure nutation. For many systems carried aboard spin-stabilized spacecraft, however, it is necessary to know the degree of nutation. This is particularly true of a system such as the Spin-Scan Cloud Cover camera which requires low nutation if its resolution capabilities are to be realized. Low nutation is also required for a system such as the Electronically De-spun Antenna if its highly directive radio beam is to be utilized most effectively.

The Nutation Sensor experiment weighs only about one and one-third pounds. It consists of a low-frequency transducer or piezoelectric accelerometer, mounted near the periphery of the spacecraft with its sensing axis parallel to the spin axis, and a signal amplifier. This type of transducer is an inertial device which requires no extravehicular references such as the Sun, Moon or stars.

During launch, the sensitive Nutation Sensor is protected against high acceleration by a caging mechanism which keeps the sensor inoperative. Not until the ATS-B is in its final orbit will the sensor be uncaged to become operative. This will be done by ground command which will fire squibs to release the caging mechanism.

Special tests will be conducted in orbit to evaluate the Nutation Sensor. During these tests, nutation will be induced into the spacecraft's spin by firing one of the jets (perpendicular to the spin axis) in the spacecraft's hydrogen peroxide reaction control subsystem. The Nutation Sensor will record the initial nutation and any residual nutation after the nutation damper has operated.

Signals from the sensor will be amplified by the experiment's amplifier and relayed to the ground stations by way of the spacecraft's telemetry system for analyses.

-more-

Nutation Damper

This is a simple device designed to remove nutation or wobble about the spin axis from the spacecraft. It is essentially a hollow tube, measuring 19 inches long by 3/8 inches inside diameter, which is half filled with liquid Mercury. Total weight of this unit is about two pounds.

The nutation damper is mounted inside the spacecraft structure off to one side but parallel with the spin axis. Any nutations introduced into the spacecraft spin cause the Mercury to slosh around in the tube. As a result, the nutation energy is dissipated in the sloshing Mercury and the nutation motion is removed.

Resistojet - Goddard Space Flight Center

The objective of this experiment is to evaluate the usefulness of a low thrust resistojet engine aboard spacecraft for such uses as spin control and orbital maneuvers. However in the ATS-B the resistojet will be used solely for conducting de-spin tests upon ground command.

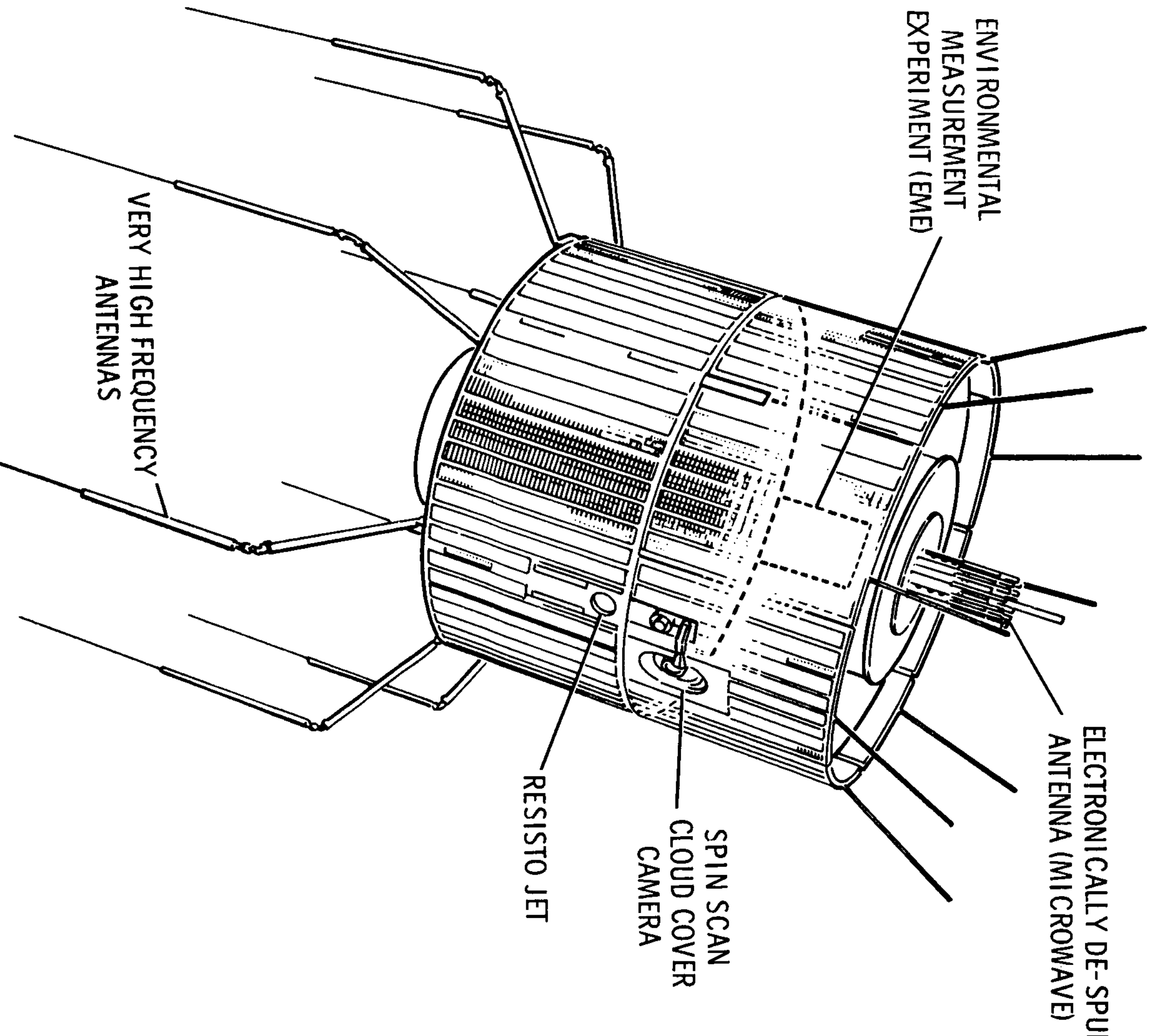
In full operation, the resistojet produces a thrust measured at 450 millionths of a pound. Continuous operation at this thrust level for four hours is adequate to de-spin the ATS-B by one revolution per minute. Enough fuel is carried to de-spin the satellite as much as 10 RPM.

The entire resistojet system is contained in a single package measuring four inches in diameter by eleven inches long. It weighs seven pounds and requires about 10 watts of power in full operation.

In addition to a propellant tank, containing a half-pound of liquid ammonia, the resistojet has a feed system and two exhaust valves located on the equator of the ATS-B. A signal conditioning unit on the resistojet enable ground stations to monitor and control its performance.

During operation, the ammonia liquid is converted to a gas at a low pressure by the regulator system. Then the gas is heated to 1,000 degrees Fahrenheit on its way to the jet expulsion system. Thrust is produced when the gas is expelled through the exhaust valves to de-spin the spacecraft.

Although the de-spin of the ATS-B resulting from operation of thr resistojet is not expected to affect the stability of the spacecraft, the ATS-B can be spun-up again during tests with the Nutation Sensor. For example, when the hydrogen peroxide jet in the spacecraft's reaction control subsystem is used to induce nutation, the effect of the spacecraft's nutation damper converts the induced nutation into spin energy. This results in spin-up.



ATS - B EXTERIOR EXPERIMENTS

SCIENTIFIC EXPERIMENTS

Environmental Measurement Experiment (EME) - Goddard Space Flight Center, and University and Industrial Laboratories

The primary scientific experiment aboard the ATS-B is the Environmental Measurement Experiment (EME). This experiment actually consists of seven separate scientific experiments integrated into a single unit. It is designed to measure the orbital environment of the ATS-B spacecraft and the effect of this environment on the spacecraft.

The major scientific advantage of the ATS-B mission is the stabilization of the spacecraft at one longitude (151 degrees W) to observe the disturbances in these belts caused by magnetic storms over long periods of time.

Radiation damage to the solar power plant of a satellite and to other components varies greatly depending upon the energy and intensity of the radiation to which the satellite is exposed. Included in the EME is an experiment to measure current-voltage characteristics of various types of solar cells when exposed to radiation. The radiation effects on the stability of various spacecraft thermal coating samples will also be evaluated.

The EME package is essentially self-contained in that it provides the seven separate experiments in the unit with a single mounting structure, an encoder, a command module, and a power supply. A power level of 24 volts is supplied to the EME package by the spacecraft power system. Signals from the EME package are encoded in a standard pulse frequency modulation (PFM) format and then sent to the ground by means of the spacecraft telemetry transmitter.

The following is a list of the experiments which make up the EME and the cognizant experimenters:

1. Suprathermal Ion Detector -- (Dr. John W. Freeman, Rice U., Houston) This experiment measures positive ions from 0.25 to 50 ev per unit charge in 20 different energy channels. A primary objective of this experiment is to determine the particle flux as a function of the direction of arrival of the ions.

2. Magnetometer -- (Dr. Paul J. Coleman, UCLA) This experiment measures the magnetic field environment of the ATS spacecraft and resolves the field into two orthogonal components; one parallel to the spacecraft's spin axis, and one perpendicular to the spin axis.

3. Omnidirectional Electron-Proton Detector -- (Dr. George A. Paulikas, Aerospace Corp., Los Angeles) This experiment measures electrons in the 0.1 to 1.4 Mev energy range and protons in the 5 to 20 and 20 to 40 Mev range, to determine the omnidirectional fluxes and spectra of the particles in the region of the spacecraft.

4. Electron Magnetic Deflection Spectrometer -- (Dr. John R. Winckler, U. of Minnesota, Minneapolis) This experiment measures the electron flux in the energy intervals 45 kev to 150 kev, 150 kev to 500 kev, and 500 kev to 1.0 mev using a magnetic deflection spectrometer.

5. Multi-element Particle Telescope -- (Dr. Walter L. Brown, Bell Telephone Labs., Murray Hill, N. J.) This experiment measures electrons, protons, and alpha particle spectra in the following energy ranges using a silicon-junction particle telescope detector:

Electrons	0.4 Mev to 1.2 Mev	2 ranges
Protons	0.7 Mev to 100 Mev	6 ranges
Alphas	1.8 Mev to 85 Mev	5 ranges

6. Solar Cell Radiation Damage -- (Dr. Raymond C. Waddel, Goddard Space Flight Center, Greenbelt, Md.) This experiment measures the I-V curves of 30 selected cells having different dopants and cover slides of different types, including the cells used on the ATS solar array.

7. Thermal Coatings -- (Jack J. Triolo, Goddard Space Flight Center, Greenbelt, Md.) This experiment measures the absorptance-to-emittance (a/e) ratio of nine selected surfaces (four spacecraft surfaces) and compares them to a standard surface (stacked blackened razor blades).

8. Ionospheric Beacon -- (Dr. O. G. Villard, Radio Science Lab., Stanford U.) In this experiment, radio signals from the spacecraft's VHF transponder as well as a tower level signal at its third harmonic, will be monitored at Stanford University and the University of Hawaii to help determine the ion content of the ionosphere. These data will complement similar data recorded at different frequencies from the Orbiting Geophysical Observatory-I and III.

By monitoring the VHF signals from the ATS-B at its relative fixed point, scientists will better be able to discern the daily behavior of the ionosphere including its motions and irregularities over a long period of time. Of particular interest are the variations of the ionosphere at sunrise and sunset.

ATS-B SPACECRAFT

The ATS-B is a spin-stabilized spacecraft with the general shape of the Syncom communications satellites, also cylindrical but much larger. It weighs 1550 pounds, about 10 times the Syncom, and measures about five feet diameter by five feet long. It will weigh 775 pounds after the apogee kick motor is fired.

The apogee kick motor protrudes from one end, the SHF phased array antenna from the other end, while whip VHF antennas protrude from the periphery at each end.

The entire cylindrical surface of the spacecraft is covered with 22,000 solar cells, except for openings for experiment sensors.

The 850-pound apogee motor was built by NASA's Jet Propulsion Laboratory, Pasadena, Cal. This motor is fitted into the base of a structure tube which runs through the center of the satellite.

It is loaded with 760 pounds of JPL-540 solid propellant. It has a maximum thrust of 6,250 pounds when operating at a chamber pressure of 260 pounds per square inch. The burn time is about 44 seconds.

Electrical Power Subsystem

This subsystem consists of an upper and a lower solar array and two nickel-cadmium batteries. Initially, it supplies about 185 watts of power. This is expected to drop no lower than 125 watts even after three years in orbit, despite the degradation caused by radiation on the solar cells. Most non-peak electrical loads can be sustained by this lower power level.

Each of the solar arrays contains 11,000 solar cells to give the spacecraft a total of 22,000 solar cells to power the spacecraft while in sunlight. These are negative-on-positive (N/P) cells which are protected against much of the space radiation damage by fused silica covers measuring 30 thousandths of an inch thick.

Each of the two batteries contains 22 cell units which provide a total storage capability of 12 ampere-hours. This is sufficient to operate the spacecraft when it is eclipsed from the sun or when transient peak loads are required.

The two solar arrays and two batteries are divided into separate power subsystems which can be paralleled into one unit on command. Each main solar array directly power spacecraft systems and maintains the voltage between about 25 and 33 volts. The upper limit is maintained by a voltage limiter and the lower by a battery discharge control circuit.

All experiment payloads and major electrical units are powered by 24-volt regulators which automatically disconnect the payloads from the spacecraft if they draw more than the prescribed current. A few high current transient loads, such as the spacecraft spin-up system and the apogee motor squibs, are not regulated in this manner. These units are automatically disconnected after firing to insure against short circuit. All of these systems can be reset by the VHF command system.

Phased Array Control Electronics (PACE) Subsystem

This subsystem provides control signals which form and despin the radio beam of the Electronically De-spun Antenna experiment used with the microwave communications systems.

The PACE uses a sun-sensor mounted on the spacecraft as a reference source to provide one pulse each spacecraft revolution. Digital circuits in the PACE give timing information between sun sensor pulses while digital-to-analog converters provide the necessary control signals for the phase shifters. A built-in clock provides a time of day correction which rotates the beam one revolution per orbit, keeping it pointed at the Earth.

Operation of the PACE during eclipse of the spacecraft is accomplished by synchronizing a stable oscillator on the ground with the sun pulses prior to eclipse and then generating and transmitting pulses to the spacecraft when it is in eclipse. The antenna beam is initially positioned and then updated as required by ground controlled signals transmitted via the spacecraft command system.

The PACE also provides for control of the antenna system of the Very High Frequency transponder experiment.

Command & Telemetry Subsystems

The command and telemetry subsystems on the ATS-B are designed to provide ground control of the spacecraft and to send experiment and "housekeeping" data back to the ground.

Command sequences are initiated at Goddard and transmitted to one of the three ground stations for ultimate transmission to the spacecraft.

The command subsystems on the spacecraft consists of two duplicate receivers and two Goddard FSK decoders. Command signals generated at a ground station are addressed to one of the command decoders but are received simultaneously by both command receivers. The addressed decoder automatically locks onto the receiver with the best signal and stores the command signal.

For verification, the telemetry subsystem repeats the command for the ground station. After verification, the spacecraft is made to execute the command signal by an execute tone sent from the ground station involved. Normal telemetry signals can be checked to verify that the spacecraft has properly executed the command.

Eight command & telemetry whip antennas are affixed to the top outside edge of the ATS-B.

The telemetry system has four two-watt VHF transmitters which operate in redundant pairs on different frequencies and two standard Goddard encoders which can operate in the pulse code modulation (PCM) or the pulse amplitude modulation (PAM) mode. Each encoder has 64 main and 96 sub-channels.

Two of these transmitters are used solely for telemetering data from the spacecraft's Environmental Measurement Experiment package. The EME has its own pulse frequency modulation (PFM) encoder.

The two remaining transmitters, operating with the telemetry subsystem encoders, are used to telemeter "housekeeping" data in both "real time" and delayed time. "Real time" data, which uses six or eight channels of an encoder in the PAM mode, includes information on the apogee motor firing, the nitrogen spin-up, and the hydrogen peroxide orientation system operations. It also includes information from the phase shifter wave forms from the microwave electronically de-spun antenna, and outputs from the Sun (psi) sensor which measures the spin rate and solar aspect angle of the spacecraft.

The remainder of the "housekeeping" data, for which there is no "real time" requirement, uses the PCM encoder mode. In this mode, the encoder samples all 64 of the main channels in three seconds and all the sub channels in three minutes.

The ATS-B carries no VHF tracking beacon since the carrier wave of the telemetry transmitters is always present and can be used for tracking purposes. Microwave tracking beacons are provided in the microwave (SHF) repeater.

Reaction Control Subsystem

The reaction control subsystem on the ATS-B consists of a nitrogen spin-up unit for spacecraft stabilization and two redundant hydrogen peroxide units for orienting the spacecraft and placing it on station in a circular synchronous orbit directly over the equator.

The nitrogen spin-up unit consists of two storage tanks containing nitrogen gas under 3,000 pounds-per-square-inch of pressure. Both tanks are connected in common to exhaust jets, which are located on opposite sides of the spacecraft and which produce about 75 pounds of initial thrust when opened.

When the spacecraft separates from the second stage Agena rocket, the nitrogen spin-up system is actuated automatically and operates for about 17 seconds, then the supply system is depleted. This spins the ATS-B up to the desired 100 rpm.

The two hydrogen peroxide units are labeled "A" and "B". Each system has its own supply tanks, two thruster jets and associated solenoid valves for operation. One thruster jet in each system fires parallel to the spin axis of the spacecraft while the other thruster jet in each system fires perpendicular to the axis. Unit "A" has two supply tanks with a full load capacity of about 45 pounds of 90 per cent hydrogen peroxide while unit "B" has twice this amount in four tanks.

Unit "B" is intended for use in re-orienting the spacecraft after the apogee motor firing and for initially placing the spacecraft on station. This will require precessing the spacecraft spin-axis so that it is perpendicular to the equatorial plane. It also may call for correcting any error in the orbital inclination so that the spacecraft is directly over the equator and moving the spacecraft across the sky from the point of orbital insertion to the planned station.

About 45 pounds of fuel in the "B" hydrogen peroxide unit is expected to be used for this purpose. This will nominally leave both units "A" and "B" units with equal amounts of fuel for future orientation and station-keeping purposes.

ATS GROUND STATIONS & TRACKING

Command sequences are initiated at Goddard and transmitted to one of the three existing ATS ground stations for ultimate transmission to the spacecraft.

Of the three ATS ground stations, two are located at tracking stations of the world-wide Space Tracking and Data Acquisition Network (STADAN) operated by Goddard. The primary ATS ground station is located at the Rosman STADAN facility which has an 85-foot dish antenna. The other is at the Mojave STADAN facility which has a 40-foot parabolic antenna.

The third ATS ground station is a transportable unit located at Cooby Creek near Toowoomba, Australia. This station is equipped with a 40-foot parabolic antenna. The antenna system employs a cryogenic low-noise, high-gain amplifier, including a combination of MASER and parametric amplifiers. Both amplifiers are operated in the same refrigerator at an actual temperature of minus 453 degrees F for the MASER and minus 430 degrees F for the parametric amplifier.

The performance of both the MASER and the parametric amplifiers will be compared in communications tests. Remote selection of either the MASER or the parametric amplifier is possible.

In addition to command equipment, these stations have Super High Frequency (SHF) and Very High Frequency (VHF) communications equipment as well as improved range-and-range-rate (R&RR) equipment for tracking purposes.

The R&RR equipment at the ATS ground stations was designed to send and receive signals through the SHF or microwave transponder on the ATS-B. The high power and broad bandwidth of this transponder provides an R&RR signal with a high signal-to-noise ratio. As a result, range of the ATS-B can be determined with a resolution of about five feet in range and approximately 1/3-inch per second in range rate.

Range is a measure of distance from a fixed ground point to the moving spacecraft, and range-rate is the rate of change of this distance from the point.

The ATS-B also will be tracked by the world-wide STADAN stations at launch and during the early phases of powered flight. In addition the STADAN will receive telemetry data from the environmental measurement experiment on-board the ATS-B.

Participating Stations

In addition to the ATS ground stations, several foreign ground stations will participate in the ATS missions. For the ATS-B mission, however, the only participating station is located at Kashima near Tokyo, Japan. This facility, operated by Japan's Radio Research Laboratory of the Ministry of Posts and Telecommunication, has a 99-foot parabolic antenna. It is equipped with SHF communications equipment and the same improved range-and-range-rate equipment used for tracking at the ATS ground stations.

EXPERIMENT, SPACECRAFT, ORBIT & LAUNCH FACTS

Experiments		
Communications		
Super High Frequency	- Test communications techniques for multiple-station access, color TV relay and other wideband data relay	GSFC
Very High Frequency	- Test ground-to-spacecraft-to-aircraft systems	GSFC FAA ARINC
Meteorological		
Spin-Scan Cloud Cover	- Evaluate spin-scan camera	Univ. of Wisconsin ESSA
WEFAX Weather Dissemination	- Evaluate dissemination of weather information via VHF	GSFC ESSA
Technology		
Electronically De-Spun Antenna	- Evaluate performance of electronically de-spun antenna	GSFC
Nutation Sensor	- Evaluate nutation damper for spin-stabilized spacecraft	GSFC
Resistojet	- Evaluate low thrust hot ammonia system for de-spin and orbital maneuvers	GSFC
Scientific		
Environmental Measurement	- Measure synchronous orbital environment and effects of same on spacecraft materials and solar cells	GSFC Univ. & Industry Labs
Ionospheric Beacon	- Monitor VHF signals from spacecraft to help determine ion content of ionosphere	Stanford Univ.

SPACECRAFT

Weight at launch:	About 1550 pounds
Weight in orbit:	About 775 pounds
Configuration:	Cylindrical structure measuring about 58 inches in diameter by five feet long.

LAUNCH

Site:	Complex 12, Cape Kennedy, Fla.
Vehicle:	Atlas (SLV-3)-Agena
Azimuth:	About 104 degrees

ORBIT (on station)

Orbit:	Synchronous (22,300 miles altitude)
Inclination:	Zero (equatorial)
Period:	24 hours

Sequence of Events: Launch to Orbital Station

The ATS-B will be launched on an azimuth of about 104 degrees. It will be placed in a synchronous, stationary, equatorial orbit where it will circle the globe once every 24 hours watching the Earth's rotational period and appearing to remain in a fixed spot above the Earth. The launch window is 8:42 to 9:42 p.m., EST. ATS-B will be placed in circular parking orbit about 112 miles above the Earth. This is accomplished with the Atlas booster engine burn (five minutes-11 seconds) and a first burn (two minutes - 43 seconds) of the restartable Agena second stage.

After about 20 minutes into the flight, the Agena will be re-ignited and burn for about one minute - 20 seconds to place the spacecraft into a highly elliptical transfer orbit. Perigee of the transfer orbit is 112 miles (same as the parking orbit altitude) and the apogee is slightly higher than the synchronous orbit altitude of 22,300 miles. This orbit is inclined about 31 degrees to the equator.

After the second burn of the Agena, the Agena guidance package will orient the spacecraft so that its apogee motor is prealigned for ignition. The ATS-B will then be separated from the Agena and spun up to 100 RPM. Spin-up occurs about two minutes - 16 seconds after completion of Agena second burn.

On the second apogee of the transfer orbit, the apogee motor on the ATS-B will be fired. This occurs over the west coast of South America about 16 hours 32 minutes after lift-off.

The 44-second burn of the apogee motor will accelerate the spacecraft into a circular drift orbit slightly higher than the synchronous orbit. This burn will remove the inclination of the orbit so that the spacecraft is directly over the equator.

In its drift orbit, the ATS-B moves westward until it reaches its final station.

Countdown Milestones at Launch Complex 12 Cape Kennedy

Event	Minus Time (Minutes)
Start Count	415
Start Agena UDMH Tanking	155
Finish Agena UDMH Tanking	135
Start Removal of Gantry	130
Complete Removal of Gantry	100
Start Agena IRFNA Tanking	90
Finish Agena IRFNA Tanking	65
Built-in Hold of 60 minutes to meet Launch Window Restrictions	60
Start Atlas LOX Tanking	45
Built-in Hold for 10 minutes to meet Launch Window Restrictions	7
Secure Atlas LOX Tanking	2
Hold for Automatic Sequencer	18 seconds
Atlas Engine to Full Thrust	2 seconds

Atlas-Agena Flight Events

Nominal Time From Liftoff (sec)	Event Description
0.0	Liftoff
129.0	Atlas Booster Engine Cutoff (BECO)
291.0	Atlas Sustainer Engine Cutoff (SECO)
294.5	Start Agena Standard Sequence Timer
311.9	Atlas Vernier Engine Cutoff (VECO)
314.0	Atlas-Agena Separation
366.8	Agena First Burn Ignition
375.5	Nose Shroud Ejection
526.8	First-Burn Shutdown
1176.5	Agena Second-Burn Ignition
1256.7	Agena Second Shutdown
1393.5	Spacecraft Separation

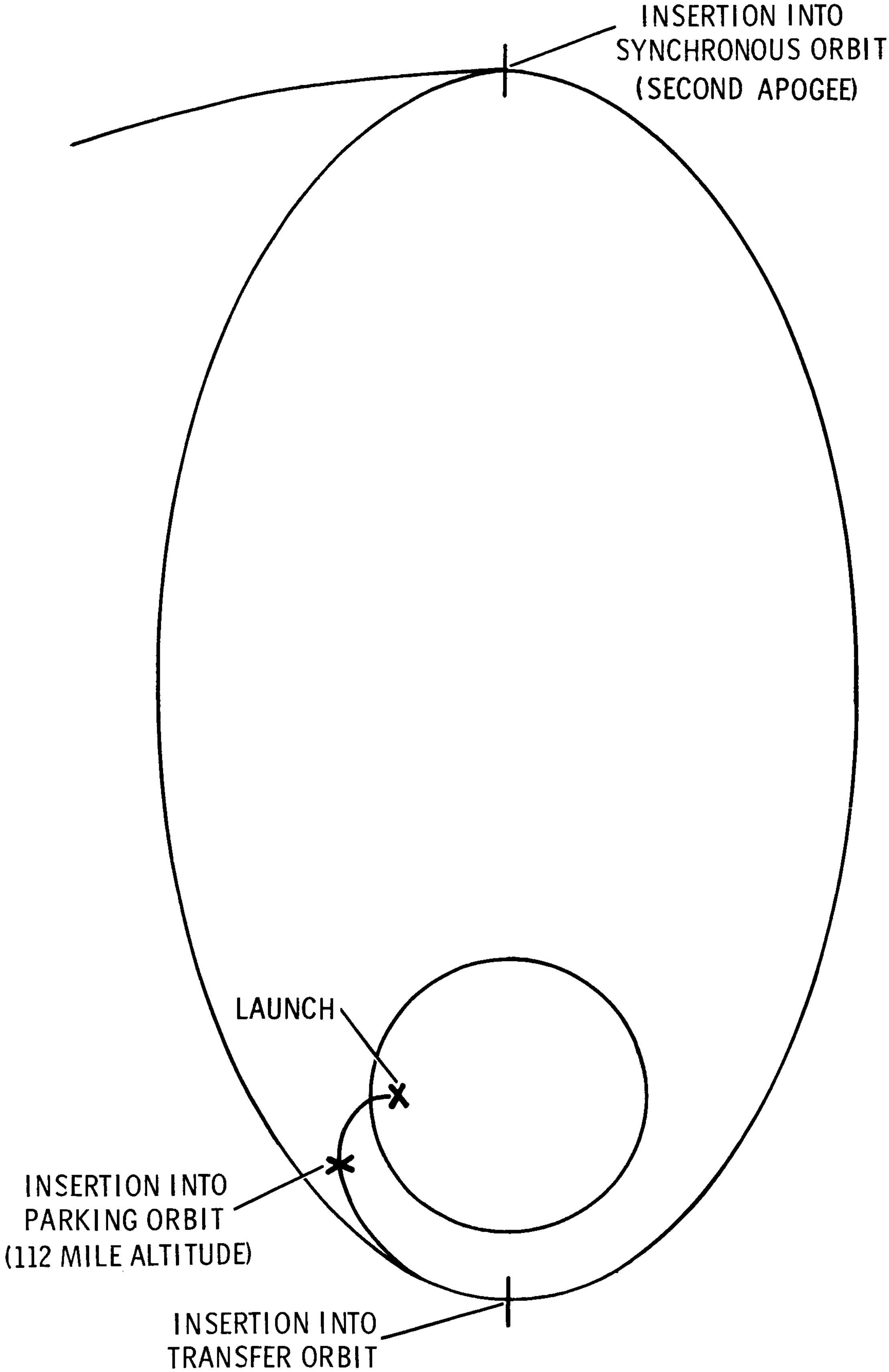
Launch Vehicles

Atlas Agena-D and ATS-B

Height on pad	109 feet
Weight on pad	278,736 pounds

	Atlas Booster	Agena-D Upper Stage
Height	67 feet	42 feet*
Weight	261,219 pounds	17,517 pounds*
Propellants	11,563 gallons RP-1	570 gallons unsymmetrical dimethyl hydrazine (UDMH)
	18,626 gallons liquid oxygen	740 gallons inhibited fuming nitric acid (IRFNA)
Thrust	388,340 pounds at liftoff	16,000 pounds at altitude
Propulsion	two booster engines one sustainer, two verniers	One regeneratively cooled engine (Bell Aerosystems)
Guidance	Atlas autopilot and G.E. guidance	Agena IRP (inertial reference package), horizon sensors, and onboard flight programmer.
Prime Contractor	General Dynamics Convair Divison, San Diego, Cal.	Lockheed Missiles and Space Co., Sunnyvale, Cal.

*Including 19 feet of shroud and enclosed payload


INSERTION INTO
SYNCHRONOUS ORBIT
(SECOND APOGEE)
LAUNCH
INSERTION INTO
PARKING ORBIT
(112 MILE ALTITUDE)
INSERTION INTO
TRANSFER ORBIT

THE ATS-B TEAM

The following key officials are responsible for the Applications Technology Satellite-B program:

NASA Headquarters

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications
Leonard Jaffe, Director, Space Applications Programs Office
Dr. Morris Tepper, Deputy Director, Space Applications Programs and Director of Meteorology
Joseph R. Burke, ATS Program Manager
Michael Garbacz, TIROS Program Manager (ATS Meteorological Flight Experiments)
Vincent L. Johnson, Director, Launch Vehicle and Propulsion Programs
J. B. Mahon, Agena Program Manager

Goddard Space Flight Center

Dr. John F. Clark, Director
Dr. John W. Townsend, Jr., Deputy Director
Robert E. Bourdeau, Assistant Director for Projects
Robert J. Darcey, ATS Project Manager
Wendell Sunderlin, Assistant ATS Project Manager
James L. Baker, ATS Project Coordinator
Robert H. Pickard, ATS Spacecraft Manager

Kennedy Space Center

Robert H. Gray, Assistant Director for Unmanned Launch Operations
Harold Zwigbaum, Agena Project Manager, ULO

Lewis Research Center

Dr. Abe Silverstein, Director
H. Warren Plohr, Agena Project Manager
Richard P. Geye, Agena Project Engineer for ATS
N. R. Marchionna, Assistant Agena Project Engineer for ATS

Major Sub-contractors

Airborne Instrument Lab, Deer Park, N.Y., Development of MASER and parametric amplifier for ATS Transportable Ground Station.

Avco, Space Systems Divison, Wilmington, Mass., Development of Resistojet.

General Dynamics Electronics, San Diego, Cal., Fabrication of Range and Range-Rate equipment at all three ATS ground stations.

General Electric Co., Communications Products Division, Lynchburg, Va., Built baseband multiplex microwave communications equipment for all three ATS ground stations.

Geophysics Corp. of America, Bedford, Mass., Development of Nutation Sensor.

Gulton Industries, Inc., Metuchen, N.J., Fabrication of EME Solar Cell experiment.

Hughes Research Center, Santa Barbara, Cal., Development of Spin Scan Camera.

Marshall Labs, Torrance, Cal., Fabrication of EME Magnetometer and Suprathermal Ion Detector.

North American Aviation, Columbus, Ohio, Built 40-foot antenna for ATS Transportable Ground Station.

Philco, Western Division Lab, Palo Alto, Cal., Integrated antenna feed system at Mojave ATS ground station.

Rantec Corp., Palo Alto, Cal., Integrated antenna feed system at Rosman ATS ground station.

Raytheon Co., Equipment Division, Norwood, Mass., Built FM and SSB communications transmitters for all three ATS ground Stations.

RCA Victor, Montreal, Canada, Built communications receivers for all three ATS ground stations.

Sylvania Electronics Systems, Waltham, Mass., Integration, test and installation of ATS Transportable Ground Station at Australia.

Westinghouse Electric Corp., Defense and Space Center Systems Divison, Baltimore. Integration, test and installation of ATS ground stations at Rosman, N.C., and Mojave, Cal. Integration of the Environmental Measurement Experiment (EME) and fabrication of the EME Thermal Coatings unit. Design and fabrication of Communications Test and Evaluation Console (CTEC) and Master Control Console at all three ground stations. Also designed and fabricated the equipment for real time recording of the Spin Scan Cloud Cover Camera pictures at the ground stations.

-END-